Indian J Phys. **80** (7), 753-755 (2006)

Note

Ultra wide band dielectric antenna for polarization independent omni directional applications

Samik Chakraborty, Bhaskar Gupta* and D R Poddar

Department of ETCE, Jadavpur University, Kolkata 700 032, India

E-mail : gupta_bh@yahoo.com

Received 4 April 2006, accepted 23 May 2006

Abstract : Frequency independent antennas had been proposed and devised for working over huge band widths. According to Rumsey [*IRI National Conventional Record* (pt1) p114 (1957)], solely angle dependent geometries are amenable to such operati This principle had so far been applied to metallic antennas only. Here, we report th retical and experimental investigati an ultra band log peri ngle dependent dielectric antenna. The antenna is of the fo m of tw rms forming a bov dipole structure which notches are cut, whose dimensions vary with logarithmic periodicity is found that the antenna offers ultra wide 3 I VSWR bandwidth of about 6.48 GHz. Further, the experimentally measured radiat on patterns show rather broad nature suitable for omni directional coverage. Varying the plane of polarization, it is also observed to have an almost polarization independent behavior. All these characteristics make this new antenna ideally suited for numerous emerging fields of wireless and mobile communications.

Keywords : Antennas, VSWR, bandwidth

PACS Nos. : 84.40 Ba, 84.90 +a

n wireless mobile or blue tooth applications at the her end of the spectrum, small omni directional antennas required which are capable of providing almost equal diation to all directions over a very wide frequency e. Though microstrip, PIFA and other planar antennas provide rather broad radiation pattern at these quency ranges, they suffer from extremely narrow ndwidth of operation [1]. Moreover, another limitation such antennas is hemispherical radiation pattern. To mate these problems, we investigate a planar dielectric thed log periodic antenna, which is defined by an le dependent geometry and hence is suitable for quency independent operation. The feeding is done by 0 ohm coaxial type SMA connector at the centre.

In spherical coordinates (r, θ, Φ), the shape of a al log periodic structure can be written as [2–5] periodic function of [$b\ln(r)$] where 'b' is a constant. example may be cited as

$$\theta = \theta_0 \sin\,[b\ln(r/r_0)]$$

It is evident that the value of θ is repeated whenever the logarithm of the radial frequency $\ln(\omega) = \ln(2\pi f)$ differs by $(2\pi/b)$. The performance of the system is then periodic as a function of the logarithm of the frequency, thus the name logarithmic-periodic or log-periodic. Photograph of the planar log-periodic structure investigated is shown in Figure 1(a). It consists of a dielectric strip whose edges

Figure 1a. Dielectric log-periodic antenna

sponding Author

are specified by the angle $\alpha/2$ as shown in its top view depicted in Figure 1(b). It consists of two coplanar arms

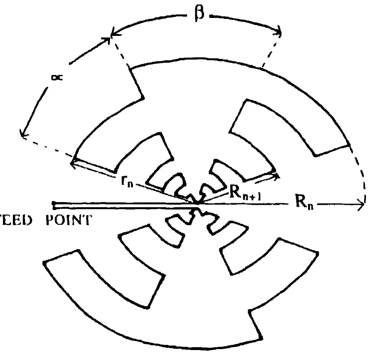

Figure 1b. Top view of dielectric log-periodic antenna

(forming a dipole) with notches cut within whose dimensions vary in successive cells according to a common ratio With reference to Figure 1(b), we choose $\tau = R_{n+1}/R_n$, $\sigma = r_n/R_n$ and $\sigma = (\tau)^{1/2}$, thus equalizing the width of the teeth and the gap between them and at the same time, we consider $\alpha + \beta = 90°$ with $\alpha = \beta = 45°$ and $\tau = 0\ 85$, so as to maintain symmetry of the dielectric structure. If the dielectric toothed log periodic antenna has certain properties (*e g.* impedance, gain *etc*) at any particular frequency f, it follows that the antenna will have the exactly the same properties at frequencies τf, $\tau^2 f$, $\tau^3 f$. and f/τ, f/τ^2, f/τ^3 and so on, provided that these frequencies are within the cut-off limits

The dielectric material chosen is Teflon with dielectric constant (ε_r) = 2 4.

$R3$ = 0 78 cm $r3$ = 0 719 cm

$R2$ = 0 92 cm $r2$ = 0.848 cm

$R1$ = 1 08 cm $r1$ = 0.996 cm

Experimentally measured return loss plot against frequency is shown in Figure 2 It shows that the minimum return loss of about −10 92 dB occurs at 10.885 GHz. In addition, it maintains ultra wide band spectrum with nearly 3 : 1 VSWR bandwidth extending from 6 1752 GHz to 12.66 GHz It is to be noted that this is the standard definition used for ultra wide band antennas [6]. Within this frequency range, it provides less than 2.5 · 1 VSWR for more than five bands of operation. The bands are of width 219 05

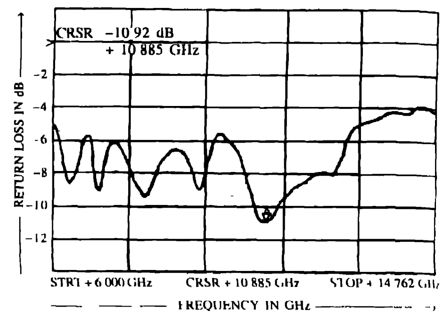

Figure 2. Return loss *vs* frequency plot

MHz about 6 329 GHz, 219 05 MHz about 6.767 GHz, 584.133 MHz about 8.044 GHz, 292 067 MHz about 9 35 GHz and 2044 467 MHz about 10 885 GHz and even <2 : 1 VSWR for 701 MHz extending from 10.555 GHz to 11 25 GHz.

Experimental radiation patterns had also been measured and are shown in Figures 3 and 4. In all four principal planes, the patterns are almost omni directional and as

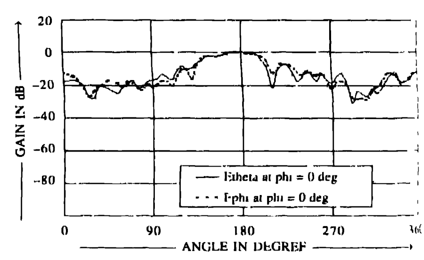

Figure 3. Radiation patterns for E_{theta} and E_{phi} *vs* theta at phi = 0 d

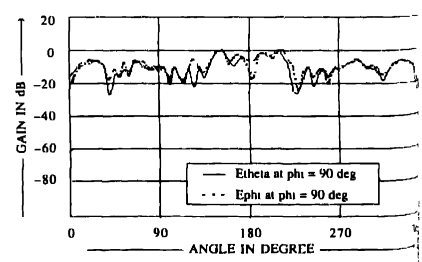

Figure 4. Radiation patterns for E_{theta} and E_{phi} vs theta at phi = deg

whole, the antenna gives an almost isotropic pattern.

Measured results indicate suitability of this wide band dielectric antenna for wireless and mobile applications with good omni directional pattern coverage over extremely wide spectral ranges Another interesting observation has been small size of the antenna, which makes it ideal for handheld mobile applications where space and weight are at premium

References

[1] R Garg, P Bhartia, I Bahl and A Ittipiboon *Microstrip Antenna Design Handbook* (Boston Artech House) (2001)

[2] J D Dyson *IRE Trans Antennas Propagat* **AP-7** p181 (1959)

[3] J D Dyson *IRE Trans Antennas Propagat* **AP-7** p329 (1959)

[4] R H DuHamel and D E Isbell *IRE National Conventional Record* (pt1) p119 (1957)

[5] D E Isbell *IRE Trans Antennas Propagat* **AP-8** p260 (1960)

[6] V H Rumsey *IRE National Conventional Record* (pt1) p114 (1957)